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This report summarizes the work performed at Physics International Company (PI) for the Office of Naval Research under contract number

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This program was to study the physics of the ion-energy boosting electrostatic lens for collective ion acceleration in the Luce diode. Experiments were to be done on the PI Pulserad 1150, using a Luce diode from a separate program to be funded by DOE. While the DOE program never materialized extensive preparatory work on the ion-energy diagnostics has been done for the ONR program. The preparatory work includes analysis of proton orbits in a magnetic field as part of the design of a mass spectrometer. A copper foil stack for nuclear activation analysis of proton energy spectrum has also been designed.

The Mass Spectrometer

A schematic of the mass spectrometer is shown in figure 1. After collimation, the ions are injected into the spectrometer where they would be deflected by a 15 kG pulsed magnetic field.

Calculations were performed to determine the orbit of a proton in the spectrometer, assuming a uniform B-field over an eight inch diameter circular area and no magnetic field elsewhere.

Copper Stack for Nuclear Activation Analysis

A copper stack detector for nuclear activation analysis of proton energy spectrum has been designed. Table 1 lists the thickness of the different layers of a copper stack which can detect protons with energies up to 220 MeV.

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Upper Limit of Proton Energy	Copper Foil Thickness	Accumulative Thickness
MeV	mils	mils
6.2	2	2
9	4	6
13	7	13
18	12	25
31	40	65
45	65	130
90	290	420
130	420	840
220	1260	2100

Table 1. Design of copper stack for Nuclear Activation Analysis of Proton Energy

The threshold of the $\text{Cu}^{63}(\text{p},\text{n})\text{Zn}^{63}$ reaction is 4.2 MeV. Knowing the spatial profile of the number of reactions from the copper stack, and with the tabulated cross-section of the $\text{Cu}^{63}(\text{p},\text{n})\text{Zn}^{63}$ reaction, the proton energy spectrum can be unfolded.

Concluding Remarks

In this collective ion acceleration program extensive work has been done in preparation for experiments on the PI Pulserad 1150. Analytic work has been done on the orbit of protons in a mass spectrometer and a copper stack for nuclear activation analysis of proton energy spectrum has been designed. Unfortunately, a parallel program which would provide the Lucc diode for the collective ion acceleration experiment never materialized. As a result no experiments were actually performed on the Pulserad 1150.

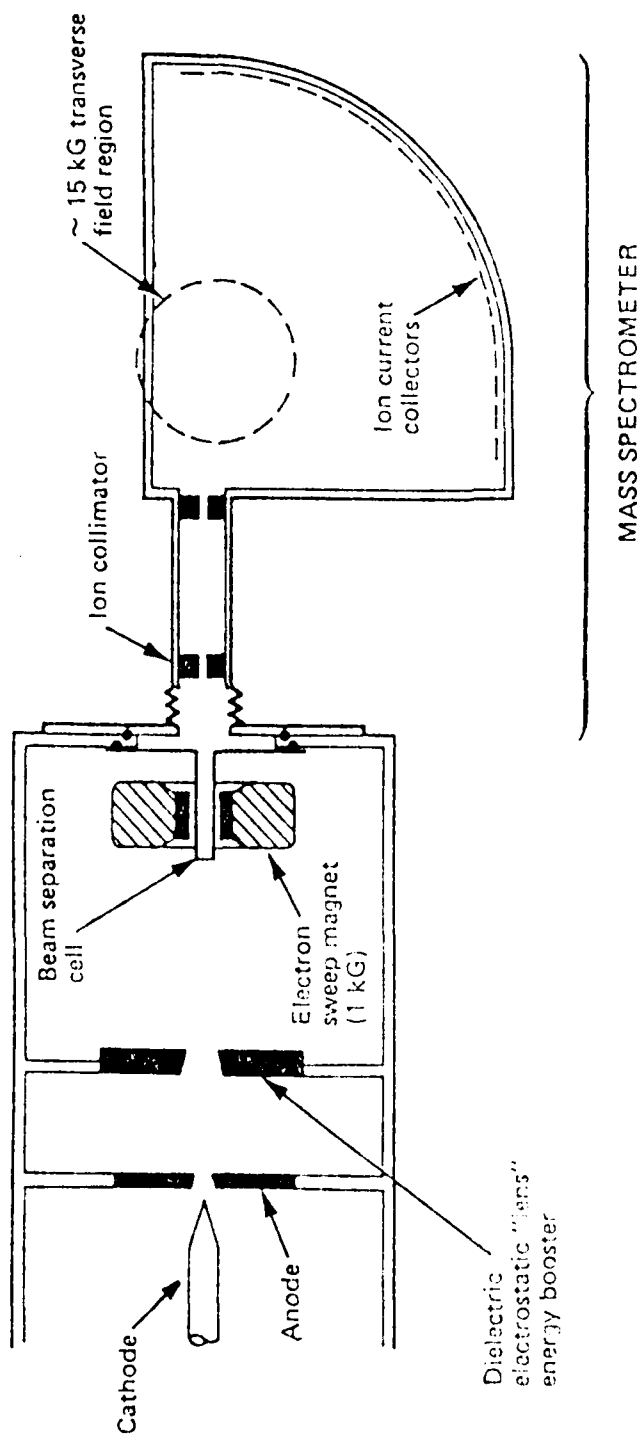


Figure 1. Schematic of apparatus for proposed Luce diode collective ion acceleration experiments showing mass spectrometer.

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